Cognate beginnings to bilingual lexical acquisition

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Abstract

Language non-selectivity is a prominent feature of bilingual lexical processing. An instance of such non-selectivity is embodied by cognateness. Recent studies have pointed to cognateness as a facilitator of vocabulary growth, and to cognates being acquired at earlier ages than non-cognates. The specific mechanisms behind such facilitation are unclear. Building on accumulator models of language acquisition, we suggest that cognateness increases the number of cumulative learning instances that a bilingual child encounters, thanks to cross-language activation. In line with previous studies, this model predicted a cognate facilitation, but only for words to which children are exposed less often. We tested these predictions against vocabulary data from 366 Catalan-Spanish bilinguals toddlers. We used Bayesian Explanatory Item Response Models to estimate participants' probability of acquisition of 604 words, conditional to the cognate status and lexical frequency of the word-form, and the age and degree of exposure to each language of the participant. We found a cognateness facilitation effect only in low-frequency words or words from the language of lower exposure. Overall, our findings support an interactive account of bilingual vocabulary acquisition in which the lexical representations in one language interact with the acquisition of words in the other language.

Keywords—lexical acquisition, vocabulary, bilingualism, item response theory, bayesian

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The foundations of word learning are in place early in age. From six months of age, infants start directing their gaze to some objects when hearing their labels, according to both experimental data (Bergelson & Swingley, 2012, 2015; Jusczyk & Aslin, 1995; Tincoff & Jusczyk, 1999) and parental vocabulary reports (e.g., Fenson et al., 2007; Samuelson, 2021). During the last half of the second year of life, new word-forms are acquired at an increasingly fast rate (Bergelson, 2020; Bloom, 2002; Fenson et al., 1994; Goldfield & Reznick, 1990; Mayor & Plunkett, 2011). Such early stages of lexical acquisition are characterised by substantial heterogeneity across different populations of language learners, reflected for instance on (the variability of) quantitative indices of lexical development, like vocabulary size (i.e., vocabulary size, Fenson et al., 1994; Frank et al., 2021). Despite this variability, trajectories of early vocabulary growth seem quite stable across languages. Tardif et al. (2008) collected data about the first ten words acquired by 10– to 16–month-old infants living in the United States, Hong Kong, and Beijing. Since birth, these infants had been learning English, Cantonese, and Mandarin, respectively. The authors found a common pattern across the three groups: their first ten words referred to roughly the same concepts, namely relatives/caregivers (*daddy*, *mommy*), social routines (*bye*, *uh-oh*) or animal sounds (*woof-woof*). These results were later extended by Frank et al. (2021) to a more diverse set of languages, and found that such cross-language commonalities are stronger at earlier stages of lexical acquisition.

Most research on early word acquisition relies extensively on data from monolingual children, and is oblivious to the fact that a substantial proportion of the world population acquires more than one language from early ages (Grosjean, 2021). Previous research on bilingual vocabulary acquisition pointed to bilingual toddlers knowing, on average, less words in each of their languages than their monolinguals peers, and also to both groups knowing a similar amount of words when the bilinguals' two languages are taken into account. Hoff et al. (2012) found that English-Spanish bilingual toddlers in South Florida (United States) knew less words in English than monolinguals did. Both groups knew a similar total amount of words when both English and Spanish vocabularies were counted together, which substantiates the importance of collecting data on both languages when assessing bilinguals' communicative development. Other studies have provided converging evidence that bilinguals know a similar or even larger number of words than monolinguals when the two languages are aggregated (Gonzalez-Barrero et al., 2020; Oller & Eilers, 2002; Patterson, 2004; Patterson & Pearson, 2004; Pearson & Fernández, 1994; Pearson et al., 1993; Petitto et al., 2001; Smithson et al., 2014). These studies rely on bilingual samples whose languages are relatively distant in typology: English is a Germanic language, while Spanish is a Romance language, and both languages differ substantially at the grammatical and the phonological level. Little is known about vocabulary acquisition in bilinguals learning a pair of typologically closer languages (e.g., when both are Romance languages).

One way typological distance may impact bilingual trajectories of language acquisition is the presence (or absence) of *cognates* in their linguistic input. Quite often, bilingual children encounter more than one label for the same referent: one in each language. For instance, an English-Spanish bilingual might hear both *dog* and *perro* in the presence of a dog We will refer to such cross-language synonyms as *translation equivalents*.[1]. Sometimes, the word-forms involved in a translation equivalent may be phonologically similar. Such form-similar translation equivalents are referred to as *cognates*. While the previously mentioned translation pair *dog* and *perro* are non-cognates (both word-forms hardly share any phonemes), the translation pair *cat* and *gato* can be considered cognates. The amount of cognates shared by a pair of languages is dependent on their typological distance. When both languages are typologically close, like Spanish and Catalan (both Romance languages), they

[1]Throughout the present study, we make the assumption that bilinguals form a common semantic representations for each translation equivalent (e.g., the concept 'dog' is shared for the English and Spanish words *dog* and *perro*). The referential contexts in which bilingual children hear (and learn) both labels may not be identical. For instance, the English word *finger* refers to eight body parts (excluding thumbs and toes), whereas its Spanish translation *dedos* refers to twenty body parts (fingers, thumbs, and toes). These discrepancies are reflected, for instance, in adults' performance in lexical decision tasks (Chaouch-Orozco et al., 2023). The fact that some translation pairs share more semantic features than others does not, however, inform whether bilinguals form common or separate semantic representations for translation equivalents. What English speakers understand for 'fingers' might not be identical to what Spanish speakers understand for 'dedos'. But when an English speaker learns Spanish, it seems implausible that they would form a separate semantic representation for what 'dedo' conveys at the conceptual level, compared to the possibility that they associate the new label to the semantic representation they already had formed for 'fingers'. Therefore, the lack of complete semantic alignment is not necessarily an argument against the existence of common semantic representations for translation equivalents. For simplicity, and in line with previous (formal and verbal) models of bilingual lexical processing (e.g., Dijkstra & Van Heuven, 1998; Dijkstra et al., 2019; Kroll et al., 2010; Shook & Marian, 2013), we assume common semantic representations for translation pairs.

are more likely to share a large amount of cognates (i.e., form-similar translation equivalents) than two typologically more distant languages, like English and Spanish (Romance and Germanic languages, respectively). Therefore, bilingual children learning two typologically close languages may be exposed to a larger amount of cognates than those learning two typologically more distant languages. For instance, in the presence of a door, a Catalan-Spanish bilingual might be exposed to the words *porta* and *puerta* (cognate translation equivalent with the common meaning 'door'), whereas an English-Spanish bilingual might hear *door* and *puerta* (non-cognate translation equivalent).

It could be the case that mapping two phonologically similar labels (cognates like *porta*-*puerta*) onto the same referent is easier than doing the same with two phonologically dissimilar labels (non-cognates, like *door* and *puerta*). If cognates are easier to acquire than non-cognates, bilinguals learning two languages that share a high proportion of cognates should benefit more often from this facilitation effect than bilinguals learning two languages with a lower proportion of cognates, and should therefore show larger vocabulary sizes. Floccia et al. (2018) provided evidence for such a facilitation effect of typological distance and vocabulary size. The authors collected vocabulary data on word comprehension and production from 372 24-month-old bilingual toddlers living in the United Kingdom who were learning English and an additional language. The additional language was one of 13 typologically diverse languages: Bengali, Cantonese Chinese, Dutch, French, German, Greek, Hindi/Urdu, Italian, Mandarin Chinese, Polish, Portuguese, Spanish and Welsh.

The authors calculated the average phonological overlap between the words in each of these additional languages and their translation equivalents in English, which was taken as a proxy of the degree of cognateness between each pair of languages. Phonological overlap was measured by computing the Levenshtein distance between each cross-language pair of phonetic transcriptions. The Levenshtein distance is a metric that computes the distance between two strings of characters/phonemes by counting the smallest number of insertions, deletions and substitutions one of the strings has to undergo to become identical to the other (Levenshtein, 1966). For instance, the Levenshtein distance for the translation equivalent *cat*-*kat* (/ˈkæt-ˈkɑt/) in English and Dutch would be one: a single edition would be needed to make both phonological translation identical (replacing /æ-ɑ/). The same translation equivalent in English and Greek (*cat*-$\gamma\acute{\alpha}\tau\alpha$, /ˈkæt-ˈɣa.ta/) would score three, as it requires at least three editions: substituting /k/ for /ɣ/, substituting /æ/ for /a/ and adding another /a/. Levenshtein distance scores are divided by the length of the longest string to normalise the similarity scores between 0 and 1. Finally, the result is subtracted from one, to get the complementary, and therefore a measure of phonological similarity, instead of dissimilarity. Following the previous examples: $1/4 = 0.25$ for /ˈkæt-ˈkɑt/, and $3/4 = 0.75$ for /ˈkæt-ˈɣa.ta/. Finally, this variable was included as a predictor of participants' vocabulary sizes. Among other findings, Floccia and co-workers reported an increase in vocabulary size in the additional language (i.e., not English) associated with an increase in the average phonological similarity between the translation equivalents of each language pair. For example, English-Dutch bilinguals (0.2214 mean phonological overlap), were able to produce more Dutch words than English-Mandarin bilinguals (0.0197 mean phonological overlap) were able to produce in Mandarin. More recently, Blom et al. (2020) and Bosma et al. (2019) reported similar results, providing converging evidence of for facilitatory effect of language distance on vocabulary size estimates.

Floccia et al. pointed to *parallel activation* as the underpinning mechanism behind their results. The parallel activation hypothesis stems from the language non-selective account of lexical access, which suggests that bilinguals activate both languages simultaneously during speech production or comprehension, even in fully monolingual environments. Evidence supporting the language-non selective account of lexical access is not restricted to production or the auditory modality, but rather extends to comprehension and translation, and to the visual modality (reading and signing) (Gimeno-Martínez et al., 2021; Hoshino & Kroll, 2008; Morford et al., 2011; Schwartz & Kroll, 2006; Schwartz et al., 2007; Spivey & Marian, 1999; van Hell & de Groot, 2008; see Kroll et al., 2013, for review). One of the clearest pieces of evidence of parallel activation was provided by Costa et al. (2000). In this study, Spanish monolinguals and Catalan-Spanish bilingual adults were asked to name pictures of common objects in Spanish. In half of the trials, the object labels were cognates in Spanish and Catalan (*árbol-arbre*, translations of *tree*), whereas in the other half of the trial labels were non-cognates (*mesa-taula*, translations of *table*), importantly such distinction was only relevant for bilinguals. Bilinguals named cognate pictures faster than non-cognate pictures, even after adjusting for the lexical frequency of the items. In contrast, Spanish monolinguals, who were unfamiliar with the Catalan translations of the Spanish words they uttered, showed equivalent naming times for the two types of stimuli. These results showed that bilinguals' Catalan phonology was activated during the production of Spanish words, facilitating the naming of cognate pictures.

Bilingual toddlers and children—still in the process to developing a mature lexicon—also show evidence of parallel activation during comprehension (Bosma & Nota, 2020; Poarch & van Hell, 2012; Poulin-Dubois et al., 2013; Schröter & Schroeder, 2016; Von Holzen & Mani, 2012; Von Holzen et al., 2019). Whether—and if so, how—the language non-selectivity shapes the early bilingual lexicon is still unclear. Previous work has pointed to an interactive account of lexical acquisition, in which toddlers' lexical representations in one language influence the acquisition of words in the other language. This cross-language facilitation is, in principle, possible since early ages: the bilingual infant lexicon consists in a substantial proportion of translation equivalents: the presence of a word in the lexicon is a good predictor of its translation equivalent also being present (Bilson et al., 2015; Pearson et al., 1995; Tsui et al., 2022). In fact, translation equivalents may even be overrepresented in the early bilingual lexicon. Bilson et al. (2015) found that bilingual toddlers produced a higher proportion of translation equivalents than it would be expected if they learned two independent lexica simultaneously, which suggests that bilingual children preferentially acquired words for which they already knew a label in the other language. In the same line, Bosch and Ramon-Casas (2014) reported a similar overrepresentation of translation equivalents in Catalan-Spanish bilinguals: a high proportion of acquired Catalan words held an also acquired translation in Spanish. Finally, a recent investigation by Tsui et al. (2022) presented a quantitative model of bilingual vocabulary acquisition which showed a consistent preferential acquisition of translation equivalents by English-French bilinguals, with such preference being stronger at early stages of vocabulary growth. Overall, these findings suggest that bilingual children benefit from a semantic facilitation effect driven by the acquisition of translation equivalents.

If translation equivalents are pervasive in the bilingual lexicon since early ages, it is possible that cognateness increases the amount of cross-language activation, boosting early word acquisition. This could ultimately lead to children who are learning languages with a larger proportion of cognates (e.g., English and Dutch) showing larger vocabulary sizes, as found by Floccia et al. There is evidence of phonological and semantic similarity facilitating word acquisition in monolinguals: infants are more likely to acquired new words that are semantically or phonologically more connected to other words, than words with poorer connectivity in either of those dimensions, such as words belonging to sparse phonological neighbourhoods (Fourtassi et al., 2020; Hills et al., 2009; Jones & Brandt, 2019; Laing, 2022; Storkel, 2004). If phonological similarity plays a cross-language facilitation role during bilingual word acquisition, cognate translation equivalents—which share both semantic and phonological similarity—should be acquired, on average, earlier that non-cognate translation equivalents—which share semantic similarity (e.g., are taxonomically related) but not phonological similarity.

Evidence supporting an earlier age-of-acquisition for cognates is scarce. Bosch and Ramon-Casas (2014) collected parental reports of expressive vocabulary from 48 Catalan-Spanish bilinguals aged 18 months, and found that cognates represented a larger proportion of participant's vocabulary than non-cognates. Schelletter (2002) provided converging evidence from a longitudinal single-case study, in which an English-German bilingual produced cognates earlier than non-cognates, on average. The low sample size in these two studies makes it challenging to draw strong conclusions about the effect of cognateness on vocabulary growth. Floccia et al.'s estimates are statistically more reliable given their remarkably larger sample size (372 participants). Although their results suggest a cognateness effect on vocabulary size, their study was not aimed at testing the effect of cognateness on age-of-acquisition at the *word-level*. The response variable in this study was the proportion of words each participant understood and/or produced (i.e., vocabulary size), from the list of lexical items in the vocabulary checklists. By aggregating the responses from all words into a single datum per child, it was no longer possible to test the effect of cognateness on word acquisition at the word-form level. Also, all participants were aged 24 months, meaning that even if the unaggregated responses to individual items were included as the response variable, age-sensitive claims about the effect of cognateness on word acquisition should be taken with caution (a limitation also present in the Bosch & Ramon-Casas, 2014, study).

More recently, Mitchell et al. (2022) addressed this issue providing a more fine grained measure of a cognateness facilitation effect in vocabulary acquisition. Using a longitudinal sample of 47 16-to-30 month-old French-English bilinguals living in Canada, the authors collected data on expressive vocabulary data in both languages. They created two lists of translation equivalents: one made of 131 cognates, and one made of 406 non-cognates. The proportion of translation equivalents that children were reportedly able to produce was higher in the cognate lists than in the non-cognate list across ages, even when both lists were matched by semantic category (furniture, animals, food were similarity represented in both lists) and age-of-acquisition norms (an index of word difficulty). These findings shed some light on the ongoing exploration of why (if at all) bilinguals' vocabulary size seems to grow faster when both languages are more similar at the lexical level. Word-forms sharing more phonemes with their translation equivalents (i.e., cognates) seem to be acquired faster. Parallel activation remains a plausible explanation for this effect. When a child is exposed to a word-form, its (phonologically similar) translation equivalent is activated, and this cross-language activation increases the chances of acquisition. The precise underpinnings of this effect are still unclear.

In the present investigation we approach the cognate facilitation on word learning by extending the conceptual framework of accumulator models of language acquisition to the bilingual case. Accumulator models formalise the widespread assumption that a child's vocabulary growth rate is a function of mainly—but not exclusively—the number of learning instances that a child has accrued with a particular word (see Kachergis et al., 2022, for review). A learning instance of a word consists, for example, in hearing such word-form (*flower*) in the presence of its referent (a flower). We devise word acquisition as a continuous process in which a child accumulates experience with a given word-form and its referential context until the number of cumulative learning instances meets some theoretical threshold. After this, we consider the lexical representation of the word as *consolidated*, which leads to a non-linear increase in the probability of caregivers reporting such word as acquired in a vocabulary checklist like the one in the present study. As infants receive linguistic input, they also accumulate opportunities to learn words until a threshold is crossed, an the word can be considered to be acquired. The rate at which monolingual children encounter learning instances with some word-form is strongly determined by age: as time passes children are exposed to a larger amount of linguistic input, and therefore accumulate more learning experiences with all words.

Not all words occur in the linguistic input with identical frequency, so children accumulate experience with some word-forms at faster rates than with other word-forms. This results in frequent words being acquired earlier in age than less frequent words (e.g., Ambridge et al., 2015; Braginsky et al., 2019; Goodman et al., 2008; Hansen, 2017; Swingley & Humphrey, 2018; Verhagen et al., 2022). For this reason, lexical frequency plays a central role in most models of lexical growth, especially in the case of accumulator models (Hidaka, 2013; Mollica & Piantadosi, 2017). Following this account, words with high lexical frequency like 'flower' (1,077 times per million words in the CHILDES corpus, MacWhinney, 2000) are predicted to be acquired earlier in age than words with low lexical frequency such as 'taxi' (581 times per million words).

We argue that previous accounts on vocabulary growth based on accumulator models are a convenient framework to study bilingual vocabulary growth. Bilinguals share fundamentally similar learning mechanisms with their monolinguals peers. Developmental divergences between both groups can be understood as the result of the the negotiation between such mechanisms and the particular demands of a dual language input (e.g., Curtin et al., 2011; Werker & Curtin, 2005). One of such divergences is the fact that bilinguals' frequency of exposure to a word-form is mediated by their degree of exposure to their languages. Assuming that bilinguals and monolinguals are exposed to an equivalent amount of linguistic input, a Spanish-English bilingual who is exposed to Spanish 80% of the time and to English 20% of the time would need more time to accumulate the same experience with 'flower' and 'taxi' than an English monolingual (who listens 100% of the time to English) would need.

In the present study, we incorporate this feature of the bilingual linguistic input to an account of the cognateness effect on word acquisition. We suggest that when a bilingual child is exposed to a given word, they not only activate its corresponding lexical representation, but also that of its translation equivalent. This co-activation is proportional to the form similarity between both word-forms. When this parallel activation is in place, each exposure to one of the word-forms may count as a learning instance for both members of the translation equivalent, in a degree determined by their cognateness. Cognate translation equivalents, for which stronger co-activation is expected, accumulate learning instances faster than non-cognates, for which weaker or no co-activation is expected. Finally, when the child has accumulator some threshold number of learning instances with any of these word-forms, its lexical representation reaches some degree of consolidation that leads to a non-linear change in the child's observed learning outputs, like the probability of such word being reported as "acquired" by caregivers, or by stronger naming effects in experimental tasks using the Visual World Paradigm (e.g., Swingley & Fernald, 2002). Because , lexical representations of cognate words accumulate learning instances faster than those of non-cognate words, the former would consolidate earlier in age.

Consider the example of the Catalan-Spanish cognate translation equivalent /ˈgat-ˈga.to/ [cat], whose word-forms share three phonemes (0.75 Levenshtein similarity). When the child is exposed to /ˈgat/, they might co-activate /ˈga.to/ in parallel, due to their phonological similarity. If this exposure to the word form occurs in a convenient referential context (e.g., in the presence of a cat), this might count as a learning instance for both active word-forms. Consider now the case of the non-cognate translation equivalent /ˈgos-ˈpe.ro/. Because of their low phonological similarity (0% Levenshtein similarity), the amount of co-activate of both words might be low, which might leads to such exposure counting as a learning instance for /ˈgos/ (which the child was exposed to), but not for /ˈpe.ro/. While /ˈgat-ˈga.to/ are predicted to benefit from parallel activation, /ˈgos-ˈpe.ro/ are not. This facilitation effect may not be equivalent for /ˈgat-ˈga.to/. If the child receives a larger amount of Catalan input than Spanish input, they will encounter the Catalan form /ˈgat/ more frequently than the Spanish form /ˈga.to/. If parallel activation is in place, the former will activate the latter more often than vice versa. Ultimately, /ˈga.to/ should benefit more strongly from its cognate status than /ˈgat/. For instance, if the previous child is exposed 80% of the time to Catalan, and 20% of the time to Spanish, words in Spanish should, on average, show an even stronger cognateness facilitation effect than words in Catalan.

Figure 1 provides a graphic, theoretical illustration of this account. We assume the case of a Catalan-Spanish bilingual child who is exposed 60% of the time to Catalan, and 40% of the time to Spanish. We also assume that the child is exposed to either word around 50 times per month, following a Poisson($\lambda = 50$) distribution. We illustrate the cumulative sum of learning instances that a child accumulates across ages for the Catalan word-form (/ˈgat/ or /ˈgos/) and its Spanish translation (/ˈpe.ro/ or /ˈga.to/). We assume an arbitrary, theoretical threshold for the learning instances at which the child is considered to have acquired a word (solid grey line). Points and triangles show the age-of-acquisition at which the amount of learning instances reaches the threshold. We show the predicted age-of-acquisition under two hypothesis: (1) a cognateness facilitation effect through parallel activation, in which both word-forms co-activate each other accumulating learning instances faster, and (2) no cognateness facilitation, for which both word-forms accumulate learning instances independently.

This hypothesis provides a convenient account for the results in Floccia et al. The size of the effect of linguistic similarity on vocabulary size that Floccia et al. reported was larger in the additional language (language of lower exposure) vocabulary than in English vocabulary (language of higher exposure). Most participants in their sample were English-dominant, meaning that their relative amount of exposure to English was larger than in the additional language. Therefore, participants may have on average learned the English word-form of translation equivalents earlier than the word-form in the additional language. Because of children's imbalance in exposure to words in English and in the additional language, the acquisition of English words by English-dominant participants might then benefit less frequently from their cognate status (the other word-form is unlikely to be available yet), while the acquisition of words in the additional language would benefit more frequently from their phonological similarity with the (more likely available) English translation.

We tested the hypothesis that the cognate effect on word acquisition is conditional to a child's exposure rate to the word. We collected vocabulary data on production and comprehension from a large sample of bilingual Catalan-Spanish children using an online vocabulary checklist designed for the present study. Participants were aged 12 to 31 months, and were exposed to Catalan and/or Spanish to varying degrees. We adopted a Bayesian explanatory item response theory (IRT, see Kachergis et al., 2022, for a similar approach) approach to model the probability of a given participant being reported to *understand* or *understand and say* each word-form in the checklist, conditional to participants age and rate

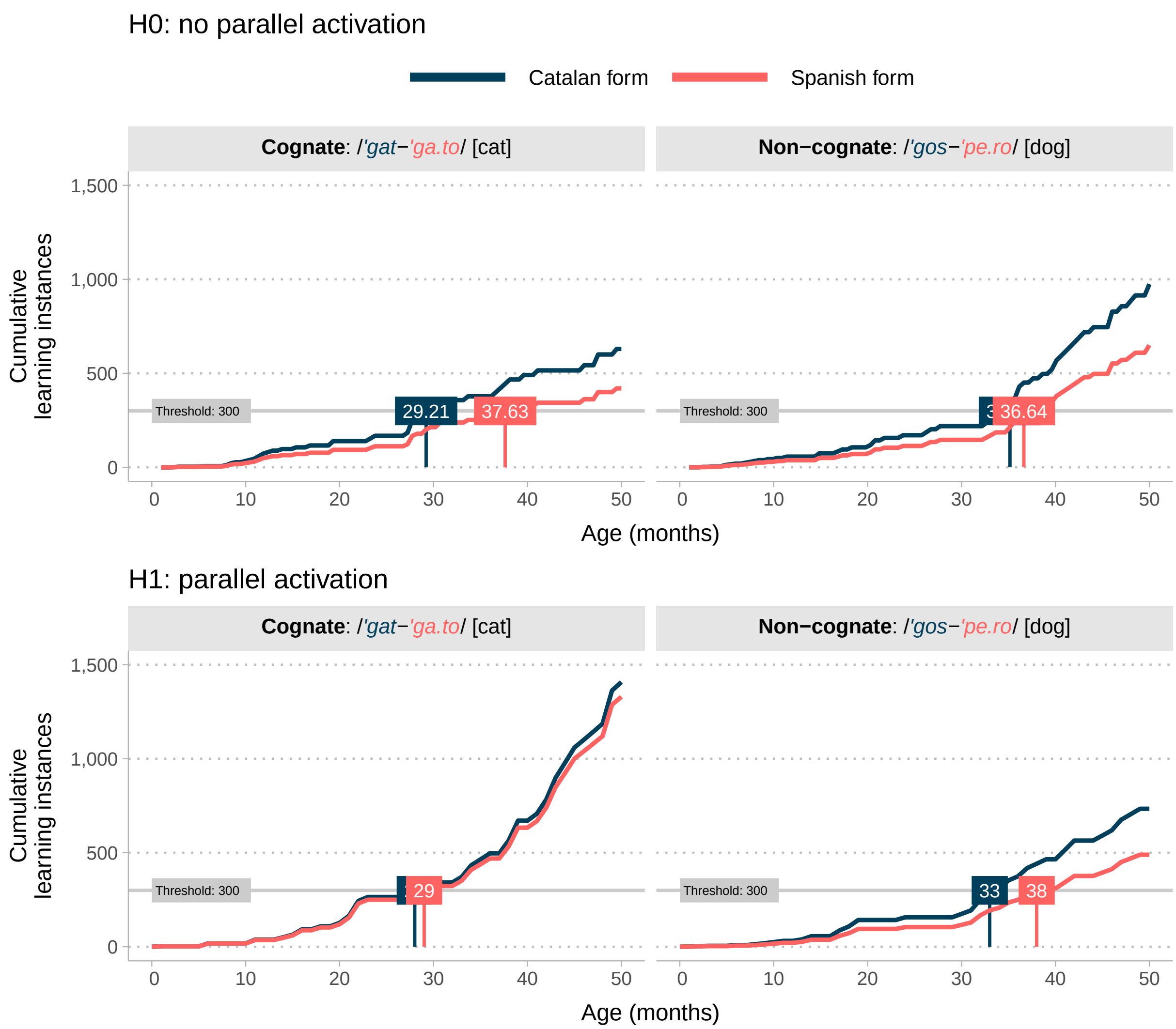

Figure 1: Schematic representation of the hypothesised cognate facilitation effect on word acquisition.

of exposure to the word-form, and the cognate status of the word-form, while adjusting for the the number of phonemes in the word-form (an indicator of word acquisition difficulty).

To operationalise participants' exposure rate to a word-form, we used a composite measure that captures the lexical frequency of the word-form (an approximation of how often a participant is exposed to it), and child's amount of exposure to the language such word belongs to. This measure was calculated by multiplying the word-form's Zipf-transformed lexical frequency to participant's degree of exposure to the language the word belongs to. Lexical frequencies were extracted from the CHILDES corpora (MacWhinney, 2000; Sanchez et al., 2019) (see Appendix A for more details). Participants' degree of exposure were reported by caregivers in a language exposure questionnaire they filled before the vocabulary checklist. Caregivers provided a proportion of the time the child was estimated to listen to any language they were spoken to regularly (described in the methods section). The resulting measure is a exposure-weighted lexical frequency measure, which was included in analyses as a proxy of how often bilingual participants were exposed to each word-form.

Cognateness was defined as a continuous measure of phonological similarity between translation equivalents. We quantified the phonological similarity between each pair of Catalan-Spanish word-forms by computing the inverse of the normalised Levenshtein distance between their X-SAMPA phonetic transcriptions (Levenshtein, 1966; Wells, 1995). This score is computed by counting the number of insertions, deletions and replacements needed by both transcriptions to become identical, dividing the resulting value by the length of the longest transcription, and finally subtracting this value from one. This results in a proportion that indicates how much the two phonetic transcriptions of the translation equivalent are similar to each other, ranging from zero (no similarity at all) to one (both transcriptions are identical) (see Floccia et al., 2018; Fourtassi et al., 2020; Laing, 2022, for similar approaches). For instance, this measure of phonological similarity returns 0% for *ocell* /`uceL`/ and *pájaro* /`paxa4o`/, Catalan and Spanish for 'bird', and returns 50% for *lluna* /`Lun5`/ and *luna* /`luna`/, Catalan and Spanish for 'moon' (see Appendix A for more details).

Finally, we included word length (numbwe of phonemes) as a nuance predictor in our analyses, motivated by previous studies reporting a strong association between word length and vocabulary size estimates (e.g., Braginsky et al., 2019; Jones & Brandt, 2019). Shorter word-forms like /sɔɫ/ (Catalan for *sun*) are generally simpler to encode as phonological representations in the lexicon than longer word-forms like /ku.kuˈðriɫ/ (Catalan for *crocodile*), and are therefore more likely to be participant a child's vocabulary.

Methods

All materials, data, and reproducible code can be found at the OSF (https://osf.io/hy984/) and GitHub (https://github.com/gongcastro/cognate-beginnings) repositories. This study was conducted according to guidelines laid down in the Declaration of Helsinki, and was approved by the Drug Research Ethical Committee (CEIm) of the IMIM Parc de Salut Mar, reference 2020/9080/I.

Questionnaire

To collect vocabulary data from participants, we created an *ad hoc* questionnaire: the Barcelona Vocabulary Questionnaire (Garcia-Castro et al., 2023). This questionnaire was inspired by the MacArthur-Bates Communicative Development Inventory (Fenson et al., 2007) and its adaptations to other languages, and was implemented on-line using the formr platform (Arslan et al., 2020). This questionnaire is structured in three blocks: (1) a language exposure questionnaire, (2) a demographic survey, and (3) two vocabulary checklists. Vocabulary checklists followed a similar structure as the Oxford Communicative Developmental Inventory (Hamilton et al., 2000) and consisted in two lists of words: one in Catalan and one in Spanish. both lists included items from a diverse sample of 26 semantic/functional categories. The Catalan checklist contained 793 items and the Spanish checklist contained 797. Items in one language were translation equivalents of the items in the other language, roughly following a one-to-one mapping (e.g., the same participant responded to both *gos* and *perro*, Catalan and Spanish for 'dog') (see Table 1 for a summary of the questionnaire items).

Table 1: Summary of the items included in the final analyses.

	List A	List B	List C	List D	Total	Examples
Household items	31	26	30	25	112	bottle, bed

Food and drink	29	26	23	27	105	water (beverage), sandwich
Animals	26	23	19	25	93	bee, owl
Outside	14	13	13	15	55	tree, ground
Body parts	14	12	11	11	48	tummy, mouth
Toys	11	11	12	13	47	box, balloon
Clothes	12	12	10	10	44	bib, button
Vehicles	9	10	11	10	40	airplane, boat
Colours	6	6	6	6	24	yellow, blue
People	7	4	6	6	23	child, grandma
Furniture and rooms	4	4	4	4	16	bath, kitchen
Time	2	2	2	2	8	day, night
Adventures	1	1	1	1	4	witch
Parts of things	1	1	1	1	4	wheel

For each word included in the vocabulary checklists, we asked parents to report whether their child was able to understand it, understand *and* say it, or did not understand or say it (checked out by default). Given the large number of words in the vocabulary checklists, we created four different subsets of the complete list of items. Each subset contained a random but representative sub-sample of the items from the complete list. Semantic/functional categories with less than 16 items—thus resulting in less than four items after dividing it in four lists—were not divided in the short version of the questionnaire: all of their items were included in the four lists. Items that were part of the trial lists of some ongoing experiments in the lab were also included in all versions. The resulting reduced vocabulary checklists contained between 343 and 349 Catalan words, and between 349 and 371 Spanish words. Participants were randomly allocated into one of the four subsets. Each response to the questionnaire provided data for a minimum of 343 and a maximum of 371 translation equivalents.

For each word included in the questionnaire, we manually generated a broad phonological transcription in X-SAMPA format. Catalan word-forms were transcribed to Central Catalan phonology, and Spanish translations were transcribed to Castilian Spanish phonology. For each translation equivalent, we calculated the phonological similarity between the Catalan and the Spanish word-form using the same Levenshtein similarity measure used in Floccia et al. (2018).

Participants

We collected 436 responses to the questionnaire from 366 distinct children from the Metropolitan Area of Barcelona between the 30th of marzo, 2020 and the 31th of octubre, 2022: 312 of those participants participated once, 42 twice, 8 three times, and 4 four times. Recurrent participants provided responses with a minimum of 25 days between responses, and a maximum of 527, and were always allocated to the same questionnaire list (A, B, C, or D). Participants were part of the database of the Laboratori de Recerca en Infància (Universitat Pompeu Fabra), and were contacted by e-mail or phone if their child was aged between 12 and 32 months, and had not been reported to be exposed more than 10% of the time to a language other than Spanish or Catalan (see Table 2) for a more detailed description of the sample). In total, 70 participants (16.06%) participants were reported to be exposed to a third language other than Catalan and Spanish. All families provided informed consent before participating. Upon consent, families were sent a link to the questionnaire via e-mail, which they filled from a computer, laptop, or mobile device. Filling the questionnaire took 30 minutes approximately. After completion, families were rewarded with a token of appreciation.

Table 2: Participant sample size by age and degree of exposure to Catalan.

	Age (months)					
Catalan exposure	[10,14]	(14,18]	(18,22]	(22,26]	(26,30]	(30,34]
75-100%	18	23	36	38	20	7
50-75%	8	13	30	41	18	1
25-50%	10	17	45	29	17	–
0-25%	7	11	21	17	8	1

We used the highest self-reported educational attainment of parents or caregivers as a proxy of participants' socio-economic status (SES). This information was provided by each parent or caregiver by selecting one of six possible alternatives in line with the current educational system in Spain: *sense escolaritzar/sin escolarizar* [no education], *educació primària/educación primaria* [primary school], *educació secundària/educación secundaria* [secondary school], *batxillerat/bachillerato* [complementary studies/high school], *cicles formatius/ciclos formativos* [vocational training], and *educació universitària/educación universitaria* [university degree]. Most families reported university studies (356, 82%), followed by families were the highest educational attainment were vocational studies (59, 14%), complementary studies (6, 1%), secondary education (8, 2%), no formal education (2, <1%) and primary education (1, <1%).

Data analysis

We collected 1,590 items responses. We restricted the analyses to responses to nouns (628 items corresponding to other grammatical classes were excluded, Fourtassi et al., 2020). We then excluded items with missing lexical frequency scores ($n = 269$), items that included more than one lemma (e.g., *mono/mico* [monkey], $n = 48$), multi-word items or phrases (e.g., *barrita de cereales* [cereal bar], $n = 9$). Finally, we removed items without a translation in the other language ($n = 32$). This resulted in a final list of 604 items, corresponding to words 302 Catalan words and their 302 Spanish translations (302 translation equivalents). After collecting participants' responses, the final dataset consisted of 138,078 observations, each corresponding to a single response of one participant to one item. Each translation equivalent received a median of 234 responses (*Min* = 106, *Max* = 872) from participants, both languages pooled together.

We modelled the probability of participants answering each response category (*No* < *Understands* < *Understands and Says*) using a Bayesian, multilevel ordinal regression model. This model allowed us to estimate both item and participant word-acquisition trajectories, while estimating the effect of our variables of interest. We added *Age* (number of months elapsed between participants' birth date and questionnaire completion), *Length* (number of phonemes in the X-SAMPA phonological transcription of the word-form), *Ex-*

posure (composite measure of Zipf-transformed lexical frequency and language degree of exposure), and *Cognateness* (a measure of cognateness, defined as the phonological similarity between translation equivalents) as population-level effects, together with their two- and three-way interactions. Predictors were standardised before entering the model by subtracting the mean of the predictor from each value and dividing the result by the standard deviation of the predictor. Participant-level and item-level random intercepts and slopes were included where appropriate, according to the structure of the data see 1. We specified a weakly informative prior around the parameters of the model (see Appendix C for details).

$$
\begin{aligned}
&\textbf{Response } (k) \textbf{ to word } i \textbf{ by participant } j \\
\text{Response}_{ij} &\sim \text{Cumulative logit}(\theta_{k_{ij}}), \\
&\text{where } k \in \{\text{No} \rightarrow \text{Understands}, \text{Understands} \rightarrow \text{Understands and Says}\} \\
&\textbf{Distribution parameters} \\
\theta_{k_{ij}} &= (\beta_{0_k} + u_{0_{i_k}} + w_{0_{j_k}}) + (\beta_1 + u_{1_i} + w_{1_j}) \cdot \text{Age}_i + \\
&(\beta_2 + u_{2_i} + w_{2_j}) \cdot \text{Length}_{ij} + (\beta_3 + u_{3_i} + w_{3_j}) \cdot \text{Exposure}_{ij} + \\
&(\beta_4 + u_{4_i}) \cdot \text{Cognateness}_{ij} + (\beta_5 + u_{5_i} + w_{3_j}) \cdot (\text{Age}_i \times \text{Exposure}_{ij}) + \\
&(\beta_6 + u_{6_i}) \cdot (\text{Age}_i \times \text{Cognateness}_{ij}) + \\
&(\beta_7 + u_{7_i}) \cdot (\text{Exposure}_{ij} \times \text{Cognateness}_{ij}) \\
&(\beta_8 + u_{8_i}) \cdot (\text{Age}_i \times \text{Exposure}_{ij} \times \text{Cognateness}_{ij}) \\
&\textbf{Prior} \\
\beta_{0_k} &\sim \mathcal{N}(-0.25, 0.5); \;\; \beta_{1-5} \sim \mathcal{N}(0, 1) \\
\sigma_{u_{0-8}, w_{0-3}} &\sim \mathcal{N}_+(1, 0.25); \;\; \rho_{u_{0-8}, w_{0-3}} \sim \text{LKJcorr}(2)
\end{aligned}
\tag{1}
$$

We assessed the practical relevance of the estimated regression coefficients of the model model following Kruschke and Liddell (2018). First, we specified a region of practical equivalence (ROPE) from -2.5% to +2.5%, in the probability scale. This region indicates the range of values that we considered equivalent to zero. The degree of overlap between the posterior distribution of a regression coefficient with the can be interpreted as support for the true parameter of the coefficient being zero or equivalent. We then computed the 95% highest density interval (HDI) of the posterior distribution of each regression coefficient. This interval contains the true value of this coefficient with 95% probability, given the data. Finally, we calculated the proportion of posterior samples in the 95% HDI that fell into the ROPE, which indicates the probability that the true value of the regression coefficient falls into the ROPE, and should therefore be considered equivalent to zero. For example, a 90% overlap between the HDI of a coefficient's posterior distribution and the indicates that, given our data, there is a 90% probability that the true value of the coefficient falls within the ROPE, and is therefore equivalent to zero.

Data processing and visualisation was done in R (R Core Team, 2013, version 4.2.2) using the Tidyverse family of packages (Wickham et al., 2019). We implemented the model using was done using the `brms` (Bürkner, 2017), a R interface to the Stan probabilistic language [Carpenter et al. (2017); 2.32.1]. We ran four MCMC chains with 1,000 iterations each and an additional 1,000 warm-up iterations per chain. Model posterior draws and predictions were handled using the `tidybayes` (Kay, 2021) and `marginaleffects` (Arel-Bundock, 2022) R packages.

Results

All parameters in the model showed adequate MCMC convergence diagnostics and little evidence of multicollinearity (see Appendix D for details). Table 3 shows the summary of the posterior distribution of the fixed regression coefficients, and their degree of overlap with the ROPE. For interpretability, we report the estimated regression coefficients transformed to the probability scale. The resulting values correspond to the maximum difference in probability of acquisition (*Comprehension* or *Comprehension and Production*) that corresponds to a one standard deviation change in each predictor[2].

[2]The logit and probability scales relate non-linearly. This means that one logit difference is not necessarily translated to a unique value in the probability scale. For example, the probability of acquisition of a given word might increase in 5% when age increases from 22 to 23 months, the probability of acquisition of the same word might only increase in 0.2% when age increases from 31 to 32 months. The linear growth of the probability of acquisition differs along the logistic curve, and therefore deciding the age point at which to report the estimates of the regression coefficients in the probability scale is not trivial. Following Gelman et al. (2020), we report the maximum value of such coefficient, which corresponds to the linear growth

Table 3: Posterior distribution of regression coefficients.

	Median	95% HDI	p(H0)
Intercepts (at 22 months)			
Comprehension and Production	0.438	[0.379, 0.496]	8.842%
Comprehension	0.936	[0.920, 0.949]	0.000%
Slopes			
Age (+1 SD, 4.87, months)	0.405	[0.357, 0.451]	0.000%
Exposure (+1 SD, 1.81)	0.233	[0.201, 0.268]	0.000%
Cognateness (+1 SD, 0.26)	0.058	[0.014, 0.104]	3.711%
Length (+1 SD, 1.56 phonemes)	−0.062	[−0.086, −0.036]	0.000%
Age × Exposure	0.071	[0.039, 0.104]	0.000%
Age × Cognateness	0.014	[0.000, 0.026]	98.474%
Exposure × Cognateness	−0.057	[−0.069, −0.046]	0.000%
Age × Exposure × Cognateness	−0.018	[−0.027, −0.010]	97.474%

The main effect of Age showed the strongest association with the probability of acquisition (β = 0.4, 95% HDI = [0.36, 0.45]), with all of its posterior samples falling out of the ROPE. A one-month increment in age increased a maximum of 0.08 the probability of acquisition. Similarly, the word exposure index (Exposure) had a strong effect on the probability of acquisition (β = 0.23, 95% HDI = [0.2, 0.27]). All of the posterior samples of this regression coefficient excluded the ROPE. The impact of this predictor on the probability of acquisition was positive: for every standard deviation increase in exposure, the participant was 0.13 more likely to acquire it. Word-form length also showed a significant association with probability of acquisition (β = -0.06, 95% HDI = [-0.09, -0.04]). For every phoneme in the word-form, participants were -0.04 less likely to know it. The 95% HDI of the regression

(i.e. derivative) of the logistic curve at the age at which most participants were acquiring a given word. This value can be approximated by dividing the coefficient in the logit scale by four: $\hat{\beta}_j/4$, where $\hat{\beta}_j$ is the estimated mean of the posterior distribution of coefficient j.

coefficient of the Age × Exposure interaction also excluded the ROPE (β = 0.07, 95% HDI = [0.04, 0.1]), showing that the effect of the word exposure index differed across ages: older children were more sensitive likely to acquire words with higher exposure rate than younger children.

The posterior distribution of the main effect of cognateness excluded the ROPE completely (β = 0.06, 95% HDI = [0.01, 0.1]). For every 10% increment in cognateness, the acquisition of a word increased in 0.01. The effect of Cognateness interacted with that of Exposure: the 95% HDI of the regression coefficient of interaction excluded the ROPE entirely (β = -0.06, 95% HDI = [-0.07, -0.05]), suggesting that the effect of cognateness on a word's probability of acquisition changed depending on participants' exposure to word. Follow-up analyses on this interaction showed that when exposure rate was low (e.g., -1 SD), cognateness increased the probability of acquisition substantially. This effect was negligible when for words with median or high exposure (+1 SD) (see Figure 2).

To rule out the possibility that cognateness facilitation effect we found was due to cognateness comprising more frequent syllables than non-cognates—and therefore not because of their cognate status itself—, we compared the syllabic frequency of cognates and non-cognates included in our analyses. To calculate syllable frequency, we first extracted all syllables embedded in the selected words. For each syllable, we summed the lexical frequency of all the words in which such syllable appeared. The resulting value provided an estimate of the number of times the syllable appears in child-directed speech, embedded within different words. Finally, for each word, we summed the frequency of its syllables, as an estimate of the syllabic frequency of the word. We fit a Bayesian model with cognateness (Levenshtein similarity) as response variable, and the main effects of syllable frequency and number of syllables (to control for the fact words with more syllables are more likely to score higher in syllabic frequency) as predictors. This model provided strong evidence for the association between cognateness and syllabic frequency being equivalent to zero (see Appendix E).

Discussion

This study investigated the impact of cognateness on the early bilingual lexicon. We used Bayesian Item Response Theory to model the acquisition trajectories of a large

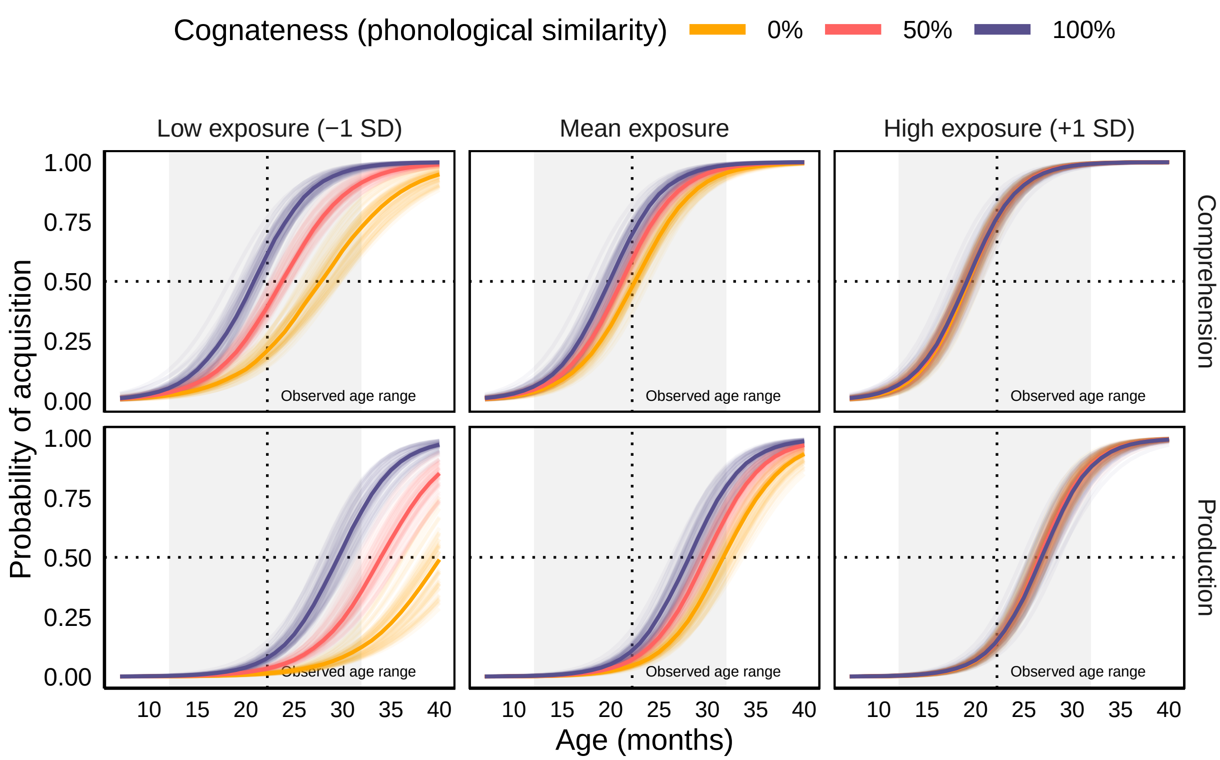

Figure 2: Posterior marginal effects. Thin lines correspond to 50 mean predictions. Thicker lines indicate the median of those predictions. Different colours indicate different levels of cognateness (phonological similarity). Predictions are presented separately for different degrees of word exposure index: little exposure to the word, mean exposure, and high exposure. Predictions for Comprehension are show on top and predictions for Comprehension and Production are shown on the bottom. In-sample predictions lie inside the grey rectangles.

sample of Catalan and Spanish words, estimating the effect of cognateness on the probability of acquisition. This model corrected for participants' age, word-form length (number of phonemes), and a novel measure of participants' exposure rate to each word. Exposure rates were calculated as a language exposure-weighted lexical frequency score in which each word-form's lexical frequency was corrected by the degree to which the participant was exposed to each language. Overall, we found that cognates (i.e., phonologically similar translation equivalents) were acquired earlier than non-cognates. This effect was mediated by exposure rate: low-exposure word-forms benefited from their cognate status, whereas high-exposure word-forms did not. Capitalising on accumulator models of language acquisition, we provided a theoretical account of bilingual lexical acquisition. In this account, parallel activation of the two languages plays a central role during the consolidation of early representations in the bilingual lexicon, and in which the dynamics of co-activation between translation equivalents results in an earlier age-of-acquisition.

This investigation is particularly relevant in the light of two previous findings. First, Floccia et al. (2018) reported that bilingual toddlers learning two typologically close languages (e.g. shared many cognates, like., English-German) showed larger vocabulary sizes than those learning typologically distant languages (e.g. shared fewer cognates, like English-Mandarin). Second, Mitchell et al. (2022) found an earlier age-of-acquisition for cognates, compared to non-cognates. The outcomes of both studies pointed to cognateness facilitating word acquisition through parallel activation. But the underpinnings of such effect were unclear: while parallel activation has been extensively described in experimental studies, current paradigms of bilingual word acquisition and word learning are, to a large extent, dissociated from the mechanisms proposed by previous work on word processing. Accumulator models of language acquisition provide a convenient theoretical framework to narrow this gap.

Following the rationale of accumulator models, we suggest that parallel activation increases the rate at which bilingual children encounter learning instances for cognate words, but not for non-cognate words. We hypothesised that when a bilingual child is exposed to a word-form in presence of its referent, they activate not only its corresponding lexical representation, but also the lexical representation of its translation. This cross-language activation occurs at the phonological level, and the amount of co-activation that spreads from the spoken word to its translation is proportional to the amount of phonological similarity between both word-forms. Cognates would receive more activation from their translation than non-cognates, leading children to accumulate learning instances with cognate words at a faster rate than with non-cognate words. As a result, lexical representations of cognate words would consolidate at earlier ages than those of non-cognate words.

Consider a Catalan-Spanish bilingual child who is exposed to the Catalan word-form /ˈgat/ in the presence of a cat. This may represent a learning instance, in which the child has the opportunity to strengthen the association between the word-form and its referent. Because the Spanish translation of this word (/ˈga.to/) is phonologically very similar to the Catalan form (both word-forms share 0.75 Levenshtein similarity), it might receive some degree of co-activation. Both members of the translation pair would be activated to some extent in the presence of their common referent, and therefore the child would accumulate a learning instance with both word-forms. The case of the non-cognate translation equivalent for *dog* (/ˈgɔs/-/ˈpe.ro/, sharing 0.00 Levenshtein similarity), would be different. Since both words hardly share any phonological similarity, a bilingual child would only accumulate learning instances for the word they encounter in speech, but not for the other. For instance, hearing /ˈgɔs/ would be unlikely to activate /ˈpe.ro/ through phonology. Each word would accumulate learning instances independently, without any cross-language facilitation taking place.

This account of bilingual lexical acquisition addresses a critical subject in bilingualism research: do bilingual infants accumulate learning experiences in both languages independently, or does exposure to one language impact the acquisition trajectory of the other language? In the context of lexical acquisition, the former scenario predicts that every learning instance for a given word-form contributes to the consolidation of the representation of such word in the lexicon, while the consolidation of its translation remains unaffected by such experience. In the latter scenario, a learning instance to the same word-form would contribute not only to the consolidation of the representation of such word, but also, to some extent, to the consolidation of its translation. Our findings provide strong support for an account of bilingual vocabulary growth in which the experience and learning outcomes accumulated by the child in one language impact those in the other language. Such a facilitatory cross-language mechanism might be an important piece in the puzzle of bilingual language acquisition. In particular, it may shed some light on why bilingual infants do not show relevant delays in language acquisition milestones compared to their monolingual peers, while receiving a reduced quantity of speech input in each of their languages. Our results provide some insights into this issue: infants benefited more strongly from the cognateness facilitation effect when acquiring words from the language of lower exposure than in the language of higher exposure.

We suggest that this asymmetry is the result of children' unbalanced exposure to their languages. A bilingual child's frequency of exposure to a given word-form is mostly determined by two factors: the word-form's lexical frequency and the child's amount of language exposure to the language such word belongs to. A dual linguistic input means lower exposure to each of the languages, unless one makes the—arguably implausible—assumption that bilinguals are exposed on average to twice the amount of linguistic input than monolinguals. Because of this difference in exposure, words lower-exposure language might receive activation from their translation in the higher-exposure language more often than words from the higher-exposure language receive activation from their translation in the lower-exposure language. As a result, the cognateness facilitation effect should be stronger in words from the lower-exposure language.

This mechanism might be extended to provide a plausible explanation for the language similarity facilitation reported by Floccia et al. The authors observed a facilitation in the additional (non-English) language: children learning two typologically close languages knew more words in the additional language than those learning two typologically more distant languages. In their sample, the additional language was consistently also the lower-exposure language for most children, while English was the higher-exposure language. Given that words in English were more likely to be acquired first, higher phonological overlap for words in the language of lower exposure (especially those of lower lexical frequency) would facilitate vocabulary growth for languages sharing more cognates with English.

It might be argued that our results reflect the fact that cognate translation equivalents are represented in the initial bilingual lexicon as the *same* lexical entry. Because cognates correspond to similar sounding word-forms in equivalent referential contexts (e.g., hearing /ˈgat/ and /ˈga.to/ in the presence of a cat), it is possible that they classify both are as acceptable variations of the same word, therefore treating them as a single lexical item. This would lead to a faster increase in cumulative learning instances, and to earlier ages of acquisition for cognate translation equivalents (for which listening to each word-form contributes to the acquisition of its shared representation), compared to non-cognates (for which listening to each word-form contributes to the acquisition of a separate representation). This mechanism could potentially explain the earlier age-of-acquisition effect of cognates found in the present study, without the need of parallel activation playing any relevant role. Mitchell et al. (2022) discuss this possibility as a possible explanation of the cognate facilitation effect, in which bilinguals only need to map one word-form to the referent in the case of cognates, while mapping two distinct word-forms in the case of non-cognates. Previous work on mispronunciation perception and minimal pair learning points in a different direction. Bilingual toddlers show monolingual-level sensitivity slight phonetic changes in a word-form, according to their performance in word recognition tasks (Bailey & Plunkett, 2002; Mani & Plunkett, 2011; Ramon-Casas & Bosch, 2010; Ramon-Casas et al., 2009, 2017; Swingley, 2005; Swingley & Aslin, 2000; Tamási et al., 2017; Wewalaarachchi et al., 2017). These fine abilities to differentiate between similar-sounding word-forms are reflected in word learning, as bilinguals seem to be able to map minimal pairs to distinct referents (Havy et al., 2016; Mattock et al., 2010; Ramon-Casas et al., 2017). Overall, it seems that bilinguals consider small differences in the phonological forms of words as relevant at the lexical level. We argue that this shows evidence that bilingual toddlers likely form distinct lexical representations for even near-identical cognates.

Our study shares similar methodological limitations with previous work using vocabulary reports provided by caregivers. Such reports can be subject to measurement error induced by caregivers who may sometimes overestimate or underestimate participants' true probability of acquisition of words (e.g., Houston-Price et al., 2007). For instance, although in the present study caregivers were explicitly instructed *not* to rely on their responses to Catalan words when responding to Spanish (and vice versa), it is possible that some caregivers assumed—at least to some extent—that because the child knew a word in one language, the child should also know the word in the other language. This bias would especially affect similar-sounding words, i.e., cognates. Production estimates may be more prompt to such biases, in part because of the slower pace at which their articulatory abilities develop, compared to their word recognition abilities. For instance, even at 47 months of age, few (typically developing) English monolinguals reach 100% intelligibility scores in word production, as rated by English native adults (Hustad et al., 2020, 2021). This gap between comprehension and production is even larger in the less dominant language of bilingual children (Giguere & Hoff, 2022). For this reason, caregivers may be more uncertain about what words can be counted as *acquired* in this modality. Despite these potential biases, vocabulary checklist filled by parents show strong evidence of concurrent validity with other estimates of vocabulary size or lexical processing (Feldman et al., 2005; Gillen et al., 2021; Killing & Bishop, 2008; but see Houston-Price et al., 2007).

The present study contributes a specific data point into the complex landscape of bilingualism research. Bilinguals are a remarkably heterogeneous population that can hardly be satisfactorily characterised in a comprehensive way (Sebastian-Galles & Santolin, 2020). Bilinguals differ across multiple dimensions. these differences span from exclusively linguistic factors such as the amount of overlap between the phonemic inventories of the two languages being learned (e.g., low, like the case of English and Mandarin, or high like the case of Spanish and Greek), to higher-level factors like the socio-linguistic situation in which the two languages co-exist (e.g., in some regions both languages are co-official and used in similar contexts, while in others, one of the languages hardly has any societal presence, i.e., heritage languages). This diversity of situations in which bilingual toddlers acquire language calls for special consideration of the generalisability of results in bilingualism research. Our sample, although homogeneous (e.g., similar parental educational level across), represents a fairly particular population of bilinguals: the languages involved in the present investigation, Catalan and Spanish, co-exist in Catalonia as official languages, both languages are used in fairly similar contexts, and both languages are known by the majority of the population. In 2018, more than 81.2% of a representative sample of 8,780 adults aged 15 years or older living in Catalonia reported being able to speak Catalan, and more than 99.5% of the same population reported being able to speak Spanish (*Els usos lingüístics de la població de*

Catalunya, 2018). In addition, and as commented in the introduction, Catalan and Spanish are both Romance languages and share a considerable amount of cognates. Extending our analyses to other bilingual populations learning typologically more distant languages, and whose languages tend to be used in more distinct contexts (e.g., heritage languages) should be a natural future step for the present investigation.

In summary, our study provided novel insights about word acquisition in bilingual contexts, and how the presence of cognates in the children's linguistic input impacts the early formation of the lexicon. We found that during the acquisition of low frequency words, bilingual children seem to benefit more strongly from the word's phonological similarity with its translation in the other language. Capitalising on accumulator models of language acquisition we, put forward a theoretical account of bilingual word learning, in which cognateness interacts with lexical frequency and language exposure to boost the acquisition of translation equivalents.

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